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(54) Method of producing a corrosion-resistant joint between metallic structural elements by spot welding

Method of producing a corrosion-resistant joint between metallic structural elements by spot welding, the method being characterized by the steps:
- pretreatment of the joining surfaces (4', 5') for
- the spot-welding operation, and
- the adhesive application of anti-corrosive layers (8), as well as
- degreasing,
- rinsing,
- pickling,
- application of a layer of sealing compound (8) on at least one side to the joining surfaces (4, 5) of one of the structural elements (4, 5),
- tacking of the structural elements (4, 5),
- spot-welding operation with
- setting of a defined electrode pressure for obtaining metallically bright joining-surface sections in the area of the electrode pressure point (10),
- current supply for producing the weld spot (11), and
- hardening of the sealing compound (8).

Description

The invention relates to a method of producing a corrosion-resistant joint between metallic structural elements by spot welding, in particular for joining structural elements in the airframe of air or spacecraft.

Welding is a generally known method of obtaining integral joining of components or structural elements that are made of the same or similar material.

The union of metal materials occurs thereby with the use of heat and pressure with or without addition of a similar material.

The invention starts from the generally known spot welding method of joining two or more structural elements to one part.

In the spot welding method that is classified as resistance forge welding, a burning electric arc is generated briefly between the two parts to be joined and the joint is produced by successive abrupt compressions.

Structural elements for air and space travel, and even those for auto manufacture require corrosion-resistant welded joining.

It is known to apply epoxy adhesive to the contact surfaces of the parts to be joined using the prior art dry spot welding method. The use of epoxy adhesives to obtain a corrosion-resistant welded joint also contributes to an additional increase in the transfer of shearing stresses to the spot weld joint; however, such adhesives are susceptible to aging and susceptible to so-called "bondline corrosion" (corrosion on the contact surfaces between adhesive and metal due to moisture in the adhesive).

To counter this disadvantage, the adhesive joints must be covered with sealing compound beads. This design represents increased labor, on the one hand, and is difficult or impossible to implement with relatively long hollow sections, on the other.

The object of the invention is to provide a method using which a completely corrosion-resistant, aging-resistant spot weld joint can be produced.

This object is accomplished by the process characteristics mentioned in claim 1 and in advantageous additional development through the characteristics of the claims following claim 1.

The method according to the invention or the means to implement the method enable, compared to known methods and means, the use of the generally known spot welding technology for joining metal components, in particular those for use on structural elements for air and space travel with their special requirements and specifications for corrosion-resistance and aging-resistance. This yields a substantial simplification and cost reduction as an alternative to the use of plastic components and adhesive components.

Particular advantages of the sealing compound used for spot welding result from the fact that the sealing compound does not flow away on oblique and vertical joining surfaces, that the sealing compounds of the type mentioned are extremely resistant to aging compared to the use of epoxy adhesives, that hardening can take place at room temperature, and that no "bondline corrosion" occurs in the sealing compound bond.

The new method, compared to the method previously used, requires no new tools, and, furthermore, with the method according to the invention, dressing of the joint is eliminated.

The sealing compounds between the structural elements to be joined to each other serves [sic], with regard to the spot weld at joint, only to permanently protect the gap between

the parts to be joined against attack by corrosion. The strength of the joint is largely produced by the weld spots.

The drawings depict, in conjunction with a spot welder, one exemplary embodiment in various steps.

They depict:
Fig. 1, schematically, a spot welder along with two structural elements to be joined, whereby the electrodes are observed applied, without pressure, on the workpiece,

Fig. 2 the spot welder along with the structural elements in an enlarged view compared to that of Fig. 1,

Fig. 3 the spot welder in an advanced operating stage, compared to the depiction according to Fig. 1 und 2,

Fig. 3a, in a detail of Fig. 3, an end elevation along the line IIIa-IIIa of Fig. 3,

Fig. 4, in an enlarged photographic cross-sectional view, a spot welding point in connection with the sealing compound, and

Fig. 5 the photographic depiction of a spot welding point in a top view of the depiction in Fig. 4, whereby the depiction is a separated spot welding point.

In the spot welder 1 of conventional construction depicted schematically in Fig. 1 and 2, reference character 2 indicates the movable pin electrode, and 3 indicates the stationary counter electrode.

The joining surfaces 4', 5' of the structural elements 4, 5 to be joined to each other are located between the two electrodes 2, 3.

In Fig. 1, reference character 7 further indicates the spot welding transformer of the spot welder 1, and 8 indicates the sealing compound layer applied to the entire joining surfaces 4', 5' of the structural elements 4, 5 to be joined to each other.

As is discernible from Fig. 3, here, the electrodes 2, 3 are applied in an advanced operating stage compared to Fig. 1 und 2, with a predefined pressure *P* to the structural element 4, 5.

Under the contact pressure *P* of the electrodes 2, 3, the sealing compound layer 8 applied in the area of the contact pressure of the electrodes 2, 3 of the joining surfaces 4', 5' is displaced to a predetermined extent on the structural elements 4, 5.

As a result of the electrode pressure *P*, a pressure point 10 is formed on both structural elements 4, 5, through which metal contact is established between the structural elements 4, 5.

The pressure points 10 are dimensioned with a larger diameter than the corresponding weld spot area 11 generated by the electrodes 2, 3 created in the spot welding operation. The work cycle with the spot welding method is such that after the displacement of the sealing compound 8 in the area of the pressure points 10 by defined electrode pressure *P* by supplying current, the weld spot 11 is then created.

At this stage in the prior art, the upset pressure of the electrodes 2, 3 on the structural elements 4, 5 is increased for welding.

The electrode pressure point 10 is dimensioned by variation of the initial electrode pressure *P* depending on the size of the weld spot 11.

The size of the diameter of the weld spot 11 is determined by the current intensity and the fusion time in the spot welding operation. In addition, the dimension depends on the amount of the pressure *P* applied by the electrodes 2, 3, and there is also a dependency of

the size of the diameter of the weld spot 11 on the type and composition of the material of the structural elements, and, moreover, on the demands placed on the strength of the finished welded component.

The difference in diameter between the weld spot 11 and the pressure point 10 should preferably be roughly 2 mm.

By maintaining the predefined difference in diameter of the points 10, 11, a collection of the sealing compound 8 in the area of the weld spot 11 of the spot welding melt is prevented, and destruction of the sealing compound by the effect of heat is ruled out.

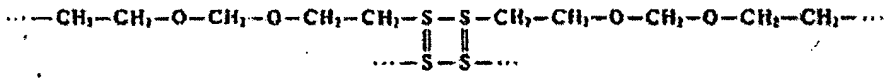
The sealing compound layer 8 may be applied to the joining surfaces 4', 5' of the structural elements 4, 5 such that the area of the end 16 of the structural elements 4, 5 is provided on both sides with a sealing compound bead 17 triangular in cross-section and, thus, the end surfaces 15, 16, otherwise subject to corrosion, are sealed by the sealing compound.

Thus, the effect generally known in the art as "bondline corrosion" between surfaces in contact with each other is countered.

The adhesives previously used in spot welding joints contain moisture that leads to corrosion of the structural elements and of the welded joint.

As one embodiment of a sealing compound for the object reported, a substance that is based on conventional polysulfide polymers may be provided.

The basic polymer has, in general, in known fashion, the chemical structure



The sealing compound preparation may be doped with water-soluble chromates. This improves the anticorrosive characteristic on light metal substrates.

The spot welding operation in conjunction with the application of the sealing compound between the structural elements 4, 5 includes essentially the following steps:

— pickling of the joining surfaces 4', 5' of the structural elements 4, 5
— application of the sealing compound 8 on the joining surfaces 4', 5' (on one or both sides, depending on the structural element)
— tacking of the structural elements 4, 5
— spot welding operation,
  — by defined electrode pressure, first displacement of the sealing compound 8 in the area of the pressure point (circular) to produce metallically bright joining surfaces in the area of the pressure point for the spot welding contact
  — current supply to produce the weld spot 11 with an increase in the electrode pressure
— cleaning of the structural elements 4, 5
— hardening of the sealing compound 8.

The photographic view according to Fig. 4 in the form of a cross-sectional depiction makes it possible to discern the two structural elements 4, 5 or their joining surfaces 4', 5', joined to each other by spot welding and the sealing compound layer 8 applied laminarly between the parts. Also discernible is the electrode pressure point 10 and the weld spot 11, where the free ring surface of the sealing compound 8 resulting from the difference in diameter between the electrode pressure point 10 and the weld spot 11 is visible.

The method described requires no additional process steps compared to standard spot welding. The weld spot does not come into contact with the sealing compound because of the displacement thereof before the spot welding. Thus, no loss in strength is introduced by the use of the sealing compound, and the quality of the spot welding corresponds to

that of dry spot welding. The sealing compound layer 8 between the structural elements 4, 5 yields an increase in strength of the spot welding, albeit only slight.

The increase amounts to approximately 1/5 of the strength that can be obtained with the use of adhesives.

The sealing compound must have characteristics such that with torsional or shearing loads [Translator note: Schäl- oder Scheerbelastung – possibly German language typos? Suggested translation as above] the sealing compound fails cohesively but not adhesively.

Claims

1. Method of producing a corrosion-resistant joint between metallic structural elements by spot welding, in particular, the structural elements of the airframe of aircraft or spacecraft, whereby a pretreatment of the joining surfaces (4', 5') for the spot welding operation and the adhesive application of anticorrosive layers as well as decreasing, rinsing, pickling occurs, characterized by the steps

— application of a sealing compound layer (8) on at least one side to the joining surfaces (4', 5') of one of the structural elements (4, 5),

— tacking the structural elements (4, 5),

— spot welding operation with

  — setting of a defined electrode pressure to obtain bright joining-surface sections (10) (circular) in the area of the electrode pressure point (10),

  — current supply to produce the weld spot (11)

  — hardening of sealing compound.

2. Method according to claim 1, characterized in that a distance of approx. 9 mm is maintained between the midpoints of adjacent spot welding points or the midpoint of one spot welding point and the edge of the component.

3. Method according to claim1 and/or 2, characterized in that the electrode pressure point (10) free due to the electrode pressure of the sealing compound (8) has a diameter greater than the electrode welding spot area (11) concentric thereto.

4. Method according to one or more of claims 1 through 3, characterized in that the sealing compound (8) is synthesized at least basically from polysulfide polymers.

5. Method according to one or more of claims 1 through 4, characterized in that the minimum layer thickness of the sealing compound layer is ca. 0.2 to 0.25 mm.